

# **The Role of Volunteer Watershed Monitors in Watershed Planning and Implementation**

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## **ABSTRACT**

Watershed restoration planning to include the Total Maximum Daily Load (TMDL) process provides the perfect vehicle for the full participation of an informed constituency. It can serve the dual purpose of lending credibility to volunteer watershed monitors as they contribute data in the development of restoration plans and TMDLs, while giving resource agencies a means to implement plans through collaboration with the community. Many states lack adequate ambient data to evaluate all water bodies and rely heavily on watershed strategies such as rapid streamside bioassessment. Pennsylvania is one of those states. Pennsylvania also has a rich history of grassroots volunteer water watershed monitoring with many of the groups heavily involved in ambient monitoring. Yet the groups themselves find it difficult to gain the credibility they need to sustain their activities. They have recently implemented a statewide network of volunteer watershed monitors to advance the credibility of volunteer watershed monitors.

Volunteers can and do play a critical role in assessing the waters in the state and provide the best hope for ensuring that impaired waters are restored.

This paper examines the role of Pennsylvania's volunteer watershed monitors in collecting water quality data, and performing lake assessments in the development of watershed restoration plans including TMDLs.

It also explores the role volunteers will play in the implementation of these plans by working on impaired waters in their local communities.

Keywords: TMDL; volunteer watershed monitoring; network

## **INTRODUCTION**

Across the nation, many energetic, hardworking individuals – adults and children alike – are involved in community based monitoring activities. They study a variety of surface and groundwater resources. These include rivers, streams, lakes, ponds, wetlands, estuaries, beaches, and wells. They often have multiple sampling stations in or on numerous waterbodies. Volunteer monitoring is an integral part of comprehensive national water protection. By monitoring water quality, volunteers empower themselves and their communities to become better water stewards. A well-designed volunteer monitoring program helps participants understand the power and limitations of scientific inquiry. Volunteer monitoring can also supplement professional monitoring in a variety of important ways:

- It can provide a screening mechanism to determine where further study is needed.
- It can assess the effectiveness of restoration efforts in watersheds.
- It may provide the only data available for a particular watershed, especially in remote areas.
- It may help collect environmental data during unusual conditions such as rainfall events or more frequently than routine sampling carried out by resource agencies.
- It can help document the presence of important flora and fauna in a watershed through observation near established monitoring stations.

Pennsylvania has a long-lived, dynamic community based monitoring movement that now goes beyond the study of aquatic systems to long-term restoration and protection for whole watersheds.

## Profile of Community Based Water Monitoring Groups in Pennsylvania

The Citizens' Volunteer Monitoring Program (CVMP) of the Pennsylvania Department of Environmental Protection (DEP) is aware of at least 180 groups involved in some sort of voluntary monitoring in their communities. The number of groups almost tripled since a 1997 survey by the program that documented the existence of 63 groups. Most monitors are part of a watershed association or school group.

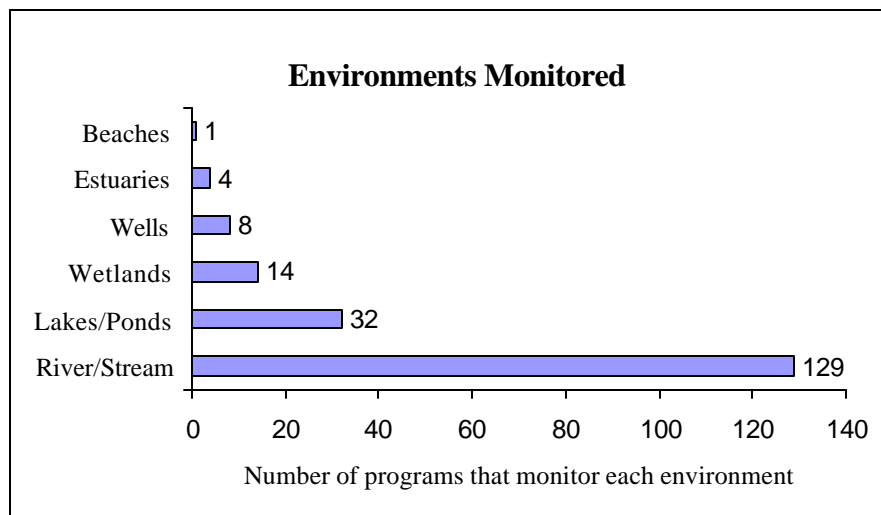
### Program Size

The community based monitoring groups tend to be small. The median size is 20. Programs with 20 or fewer volunteers account for the majority of the groups. This tends to underscore the grassroots nature of the volunteer monitoring efforts in Pennsylvania. Many programs consist of a small group of concerned citizens monitoring a small watershed or stream stretch.

### Environments Monitored

Pennsylvania has 83,161 miles of rivers and streams. So it is not surprising to find that 93% of all groups reported monitoring this environment as shown in Figure 1. This is similar to the 1997 survey results, which indicated 90% of groups monitoring flowing waters. While lakes finished a distant second with only 32 groups or 23% reporting lake monitoring, this number has increased from less than 10% (7 groups) in 1997. Fifty percent of groups are monitoring more than one environment as well as reporting an interest in watershed planning land use surveys and wildlife monitoring. All this indicates a move away from concentration of efforts on a single stream stretch to a concern with the entire watershed.

**Figure 1**



### Indicators Monitored

Table 1 shows the number of volunteer monitoring programs that monitor each indicator. Since so many groups monitor river or stream environments, indicators that are typically monitored in flowing water tend to rank high in the table. The top three indicators – pH, water temperature and dissolved oxygen – also scored high in the previous survey. They are relatively easy to measure and are important indicators of the ability of surface waters to support the fourth indicator – benthic macroinvertebrates. Nutrients – nitrates and phosphates, which are difficult to measure accurately in the field, are popular amongst the volunteers because of the importance of these indicators in gauging non-point sources of pollution. The low number of groups that measure pesticides and hydrocarbons reflects the unavailability of accurate low cost analysis methods. Costly laboratory analysis is usually the only option available to volunteers. It seems likely that many more community-based groups would want to test for these indicators if they had the resources to do so. Since this is not the case, volunteer monitors

assess the biological response of organisms such as macroinvertebrates, fish, aquatic vegetation, birds, and other wildlife. The abundance and diversity of these organisms reflect the overall health of the system and suggest whether toxic levels of pollutants may be present.

**Table 1**  
***Indicators Monitored***

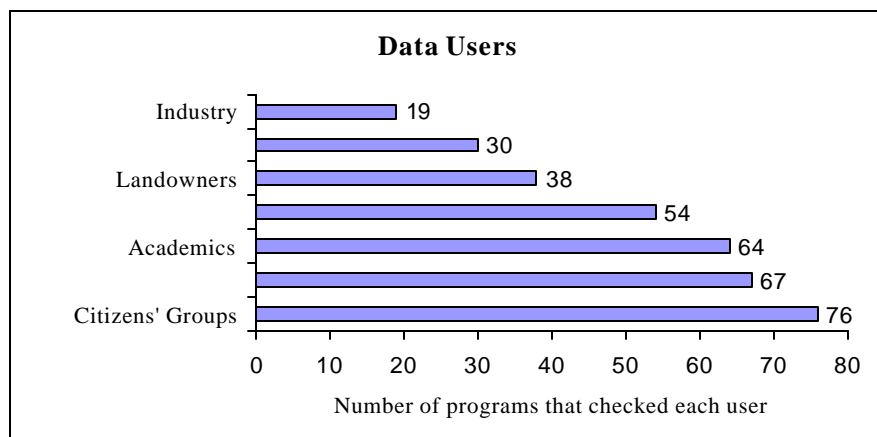
<i>Rank</i>	<i>Indicator</i>	<i>Number (%) of Programs</i>
1	pH	127 (92%)
2	Water Temperature	126 (91%)
3	Dissolved Oxygen	106 (77%)
4	Macroinvertebrates	104 (75%)
5	Nutrients (Nitrates & Phosphates)	101 (73%)
6	Alkalinity	75 (54%)
7	Turbidity	65 (47%)
8	Habitat Assessment	56 (41%)
9	Flow/Gauge	50 (36%)
10	Hardness	46 (33%)
11	Site Inspections	45 (33%)
12	Fish	37 (27%)
13	Rainfall	37 (27%)
14	Aquatic Vegetation	35 (25%)
15	TSS/TDS	31 (23%)
16	Chlorides	30 (22%)
17	Metals	29 (21%)
18	Coliform Bacteria	25 (18%)
19	Birds/Wildlife	23 (17%)
20	Debris Cleanup	22 (16%)
21	Secchi Transparency	17 (12%)
22	BOD	16 (12%)
23	Conductivity	13 (10%)
24	Photographic Survey	13 (10%)
25	Watershed Mapping	10 (7%)
26	Sediment Assessment	8 (6%)
27	Stream Channel Morphology	7 (5%)
28	Chlorophyll	6 (4%)
29	Pesticides	4 (3%)
30	Pipe Survey	3 (2%)
31	Hydrocarbons	3 (2%)
32	Acidity	2 (1%)

### **Data Uses and Users**

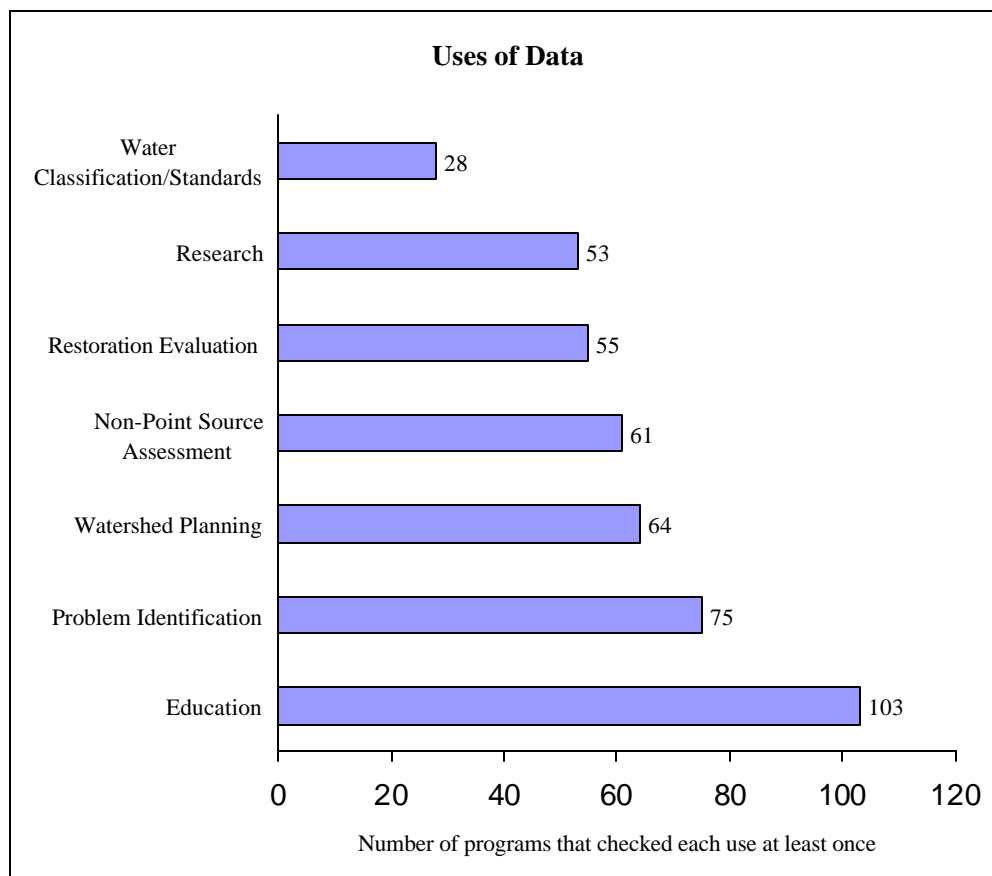
Figure 2 and 3 show the data uses and data users reported by the groups. The majority of groups reported multiple uses for their data and more than one data user. The number one use for community based monitoring data is education with the groups themselves as the primary user of data collected. This is an interesting result because ensuring that volunteer collected data is put to some use is often the dilemma for coordinators of community based monitoring programs. The last thing volunteers wish to do is collect endless mountains of data

that will grace the shelves of storage sheds for years to come. Discussion of volunteer data use often turns to identifying data users outside the organization such as the state and federal government. Yet this survey indicates that the groups themselves are using the data to educate themselves and their communities. Pennsylvania has over 2000 municipalities that govern land use decisions. It is no surprise then that volunteer monitoring groups identify local government as a popular data user as the concern of many community based organizations is the effect of development on their watersheds.

**Figure 2**



**Figure 3**



## **Funding**

Community based water monitors collectively spend over \$1,000,000 in Pennsylvania annually. Annual budgets and sources of revenue for community based monitoring tend to underscore the local and grassroots nature of the movement in Pennsylvania. Although the range for budgets is from \$0-\$100,000, the median approximate annual budget is \$3,000 with many groups operating on \$500 or less. Table 2 illustrates funding sources. Fifty-four groups or 39% of the total number reporting chose “other” as a source of funding which is nearly always local. Common examples include school districts, community based fund raising events and municipal agencies. In addition, 53 groups (38%) reported that funding comes largely from dues paid by monitors. So, not only are volunteers willing to give of their time to know their water resources better but they are also willing to pay to do so.

**Table 2**  
***Funding***

<i>Funding Source</i>	<i>Number of Groups</i>
Other	54 (39%)
Dues	53 (38%)
State Government	31 (23%)
Foundation	20 (15%)
Corporation	18 (13%)
Federal Government	18 (13%)

The Environmental Stewardship Act of 1999 has made available \$650 million in grant money. This money is utilized throughout Pennsylvania to assess and restore watersheds. This source of funding has caused a dramatic increase in stewardship activities including monitoring and restoration projects by community based groups.

## **Quality Assurance**

Many groups have a written study design or Quality Assurance Project Plan. The CVMP hosts workshops to help groups write a study design for their monitoring programs.

## **Longevity and Sustainability of Programs**

Volunteer monitoring is not a new concept in Pennsylvania. The average age of the groups surveyed is 7.5 years with 5 groups reporting over 20 years of monitoring and 3 groups with over 30 years of monitoring.

Many groups form around a single issue such as concern over a certain development that watershed residents believe will adversely impact water resources. An example is the White Clay Creek Streamwatch, which began in 1990 due to concerns caused by the rapid development taking place in the watershed. Another group, the Little Juniata Watershed Association, was formed when a group of anglers noticed a dramatic decrease in the mayfly population. The anglers alerted a Pennsylvania DEP biologist who confirmed their findings. The decrease in macroinvertebrates in the Little Juniata River was attributed to a pesticide spill of unknown origin. The volunteers are now assisting DEP in monitoring the recovery of the river ecosystem.

While it is typical that a group form around a single issue, those groups that sustain their programs over many years are usually driven by a number of concerns about the health of their streamstretch or watershed. These groups move beyond the single issue that brought them together and often become involved in efforts to educate the community. They also become involved in restoration activities based on the data they collect.

### **Pennsylvania Department of Environmental Protection Citizens' Volunteer Monitoring Program**

The Pennsylvania DEP has a CVMP that was initiated in 1996 to provide support and technical assistance to community based water-monitoring efforts. The goals of this program include:

- Fostering stewardship by helping communities find the tools needed to meet their own goals in gathering information about water resources.
- Giving the department a better understanding of water resources by receiving quality assured data from volunteers.

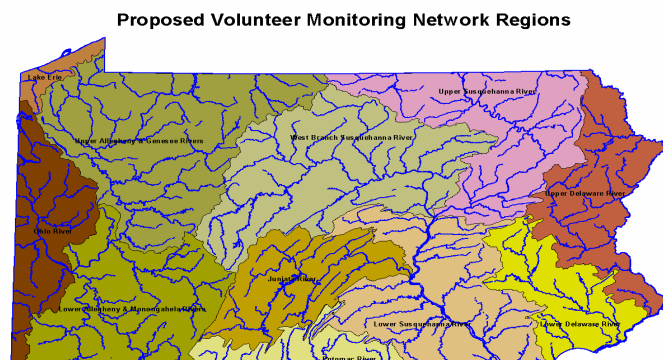
### **Volunteer Environmental Monitoring Panel and Keystone Watershed Monitoring Network**

In order to meet the needs of the dynamic community of volunteer monitors, the CVMP has undertaken a variety of activities including the formation of a statewide Volunteer Environmental Monitoring Panel. The Panel was made up of representatives from the volunteer monitoring community, business and industry, the agricultural community, organizations that provide services to volunteer monitoring groups and resource agencies. One of the original intentions of the panel was to create a forum for discussion and sharing of information between various entities involved in or concerned about monitoring and water quality issues. The panel, in conjunction with the CVMP, hosted a statewide summit of volunteer water monitors in 1999. Over 200 volunteers gathered at this summit and suggested the formation of a statewide network to promote communication and information exchange among groups, house a data clearinghouse, identify resources for support and allow local groups to speak with a larger voice. Participants at the summit also described the network as needing paid staff, organizing data by watersheds and adopting a handbook of standardized methods. In July 2000, the Panel developed into the Volunteer Watershed Monitoring Network Steering Committee to guide the process of building a statewide network of volunteer watershed monitors. The goals of the network dubbed the Keystone Watershed Monitoring Network are to:

- Facilitate communication and support to volunteer watershed-monitoring groups.
- Establish and coordinate training protocols and materials that are recognized by a variety of data users.
- Identify solutions for addressing the current and future needs of volunteer watershed monitors.
  - Advance the recognition and credibility of volunteer watershed monitors to address local and statewide issues.
  - Elevate the effectiveness of volunteer watershed monitoring groups through:
    - Sound and current scientific strategies
    - Organizational strategies
    - Communication strategies
    - Restoration strategies
    - Distribution, interpretation and use of data

The structure of the network includes the volunteer monitoring groups divided among eleven sub-watershed monitoring regions as illustrated in Figure 4.

**Figure 4**



Each monitoring region has named a delegate to serve as a member of the Volunteer Watershed Monitoring Network Steering Committee.

### **Technical Handbook**

Community based monitors in Pennsylvania use a variety of methods for sampling and analysis. Instead of attempting to prescribe standardized protocols for all 180 groups, the CVMP in collaboration with River Network and the Panel has prepared a technical handbook – *Designing Your Monitoring Program, A Technical Handbook for Community Based Monitoring in Pennsylvania* – that includes a study design process. This process is a logical series of choices about the why, what, when, where and how of monitoring. With a written study design, each group will have a clear game plan to guide them through their monitoring program and lend credibility to their data collection and any actions that result from information gathered. The group also identifies the data user in this process so that clear data quality objectives and quality assurance measures can be set up front before monitoring occurs. Defining a purpose, data use and data users are clearly the most critical part of the study design process advocated in the handbook.

Four potential purposes are defined in the handbook as described below:

**Purpose A: Education and Awareness** to promote watershed stewardship, raise awareness of watersheds as living communities, give participants experience in scientific inquiry, and improve awareness of local officials of the impacts of decisions (including cumulative impacts) on the watershed. The information collected will be used to increase people's understanding and appreciation of the way watersheds work. The goal is that they will act on this understanding to minimize their impacts on the integrity of the ecosystem.

**Purpose B: Baseline Data Collection** for trend analysis, problem and positive attribute identification, and screening. The information collected will be used at the community or watershed level to track trends over a relatively long period of time to see if the ecosystem and human uses of it are improving, staying the same, or getting worse. Or, the information will be used to quickly identify problems in order to assess the need for some corrective action or further study. Conversely, the information can be used to identify successes or community assets to enhance human uses of the watershed.

**Purpose C: Community and/or Watershed Level Assessment** of current conditions, the effectiveness of solutions and the development of community level non-point source remediation plans. The information collected will be used at the community or watershed level to assess the current condition of the watershed in order to

identify the nature and extent of problems (impairments of ecological functions and human uses). This may lead to the development of a non-point source remediation plan by communities under the state's unassessed waters strategy. Finally, this same information, gathered over time, will be used to assess the effectiveness of the plan, or specific measures, in restoring watershed integrity and human uses.

**Purpose D: State and Federal Agency Assessment** of current conditions and the effectiveness of solutions, supplement agency data collection and for use by research entities. The focus for DEP's use will be on assessment and planning, rather than enforcement actions that require strict protocols and chain-of-custody procedures.

The information collected will be used by the Pennsylvania DEP in conjunction with its own data, as part of its biennial assessment for Congress of the state of the state's waters (under section 305(b) of the Federal Clean Water Act). The handbook also contains more than 20 "surveys" or monitoring packages that can be tailored to the goals and needs of the group.

### **Training and Technical Assistance**

The CVMP has an extensive training program that is tailored to the needs of the volunteer monitoring groups. Over the five years of its existence the CVMP, in collaboration with River Network and other service providers, has held over 150 workshops on topics of interest to community based water monitors including: Increasing Your Credibility, Instream Methods for Monitoring Chemical, Physical and Biological Indicators; Abandoned Mine Drainage and Monitoring; Quality Assurance and Quality Control; Monitoring Study Design; Stream Corridor Restoration and Monitoring; and Lake Monitoring. The program also provides "workshops on demand" which are specifically planned and tailored to the goals of a particular group. The CVMP also provides technical assistance and mentoring to community based monitoring groups.

### **Pennsylvania Senior Environment Corps**

The CVMP has worked with the Environmental Alliance for Senior Involvement to create 24 Senior Environment Corps sites throughout the state. The Pennsylvania Senior Environment Corps use standardized protocols under the guidelines of a statewide Quality Assurance Project Plan to assess physical and chemical indicators of stream health once a month. They also do a habitat assessment and water quality rating using benthic macroinvertebrate communities twice a year. This data can be used as a screening tool to determine where further study is needed and the success or failure of restoration efforts. The data is housed in a statewide database that includes an open component that can be utilized by other volunteer monitoring groups not following the Corps's standardized protocols.

### **Watershed Snapshot**

The program in collaboration with the Delaware River Basin Commission plans and implements an annual statewide *Watershed Snapshot*. The goals of this event are to:

- Promote watershed education and awareness
- Recognize the ongoing efforts of community based water monitoring groups
- Foster the link between community based water monitoring groups and professional monitors
- Promote and strengthen the network of community based water monitors

During *Watershed Snapshot*, thousands of volunteers and professionals collect water quality data at their routine sampling stations during a ten-day period in April that includes Earthday. They employ the scientific equipment and methods of analysis they have available and routinely use. No limitations are placed on how to choose the monitoring sites. In many cases, streams or lakes are chosen based simply upon their proximity and accessibility to participants. Participation packets containing data sheets with spaces to record data about physical, chemical and biological indicators along with a habitat assessment are sent to hundreds of addresses across the state. Data sheets are returned to the CVMP. The program compiles the data into a report that can be used as an educational tool. The data is "democratized" – all data is used without regard to the data quality objectives employed – to develop a "picture" of the overall waters quality in Pennsylvania. The data collected can be used to get a better



picture of the ranges in results that can be expected, as well as determining trends and effects of physical influences upon water chemistry.

### **The Role of Community Based Monitoring in State Assessments**

DEP uses data in a variety of ways that focus primarily on monitoring the ecological health of the waters and impacts of toxic pollutants on public health. One of the monitoring activities carried out in assessing the state of the waters is a long-term water quality network of 150 fixed monitoring stations on rivers, streams and lakes throughout the state. These stations are located in major streams, selected reference waters, and selected lakes. Each of the stations is sampled for stream discharge or lake height and for a variety of chemical and physical indicators. A biological evaluation using benthic macroinvertebrates is carried out once per year at routine stations and three times per year at reference stations. This water quality network does not cover the majority of Pennsylvania's 83,161 stream miles. Consequently, the state has undertaken an Unassessed Waters Strategy to evaluate all of these waters with priority given to waters where there is potential for non-point source pollution. DEP also carries out Aquatic Life Special Water Quality Protection Surveys. The purpose of these surveys is to assess the need for special protection and to revise the state water quality standards if necessary. DEP also conducts Cause/Effect Surveys to determine if specific sources of point or non-point source pollution are causing known problems. Use Attainability Studies are carried out to review and revise, if necessary, water quality standards to ensure that designated fish and aquatic life uses are protected. DEP also carries out lake assessments and maintains an Ambient and Fixed Station Network Monitoring Program to monitor the general quality of groundwater.

Community based monitoring plays a vital role in state assessments. Volunteer monitors in Pennsylvania sample daily, monthly, semi-annually and quarterly at over 3000 sampling stations throughout the state. The information that is collected in a variety of ways can be used to supplement the 150 stations on the water quality network. It can and also has been used as a screening tool to raise a red flag to trigger a Cause/Effect Survey or a Use Attainability Study. Data collected under a written quality assurance/quality control plan that follows strict criteria concerning age of data, identification of a stream segment, and frequency of sampling has been used in the compilation of the Water Quality Assessment 305(b) report and resulting 303(d) list of impaired waters.

Volunteers are presently involved in collecting bacteriological data that will be used in determining recreational use suitability on 400 segments of surface waters that are on the 303(d) list of impaired waters. The bacteriological study began in the summer of 2001 and will continue in 2002. It allowed volunteers to assist in sampling two streams suspected of having bacteriological contamination. The analysis for fecal coliforms, *E. coli*, and *Enterococci* showed that the streams were impaired. The information will be used in TMDL development.

Volunteers are also collecting data on lakes for the 305(b) report. Three volunteer lake associations took part in the monitoring program in 2001. They monitored alkalinity, TSS, pH, dissolved oxygen, secchi depth, chlorophyll a and total phosphorous. The results indicated that the lakes had good water quality although one was borderline eutrophic based on the trophic state indices. In addition to the 305(b) report, the volunteers will use the information to manage their lakes. Thirteen additional groups will take part in the program in 2002.

The handbook – *Designing Your Monitoring Program, A Technical Handbook for Community Based Monitoring in Pennsylvania* – has an entire tract dedicated to educating the public on how a monitoring program must be designed and implemented if the goal is to have data usable in the 305(b) report and 303(d) list if the stream segment is not attaining the applicable water quality standard. The CVMP in collaboration with the Pennsylvania DEP's Division of Water Quality Assessment and Standards solicits outside sources of data to be utilized by the Department in the 305(b)/303(d) process. Watershed associations, community based monitoring groups and others are provided with detailed guidance on data collection and reporting requirements. Data would need to be less than five years old and collected from stream segments. For water chemistry, a minimum of 24 samples for each site is required. Macroinvertebrates may be identified to family level if the volunteer completed DEP approved training. Otherwise, the identification must be to genus. The CVMP will train volunteers on proper

protocols and screen volunteer submittals for completeness before forwarding them to the Division of Water Quality Assessments and Standards for review.

There are pathways that go beyond these more traditional avenues for use of data collected by community based monitoring groups. The CVMP is working with three groups that have funding through the Environmental Protection Agency under section 319 of the Clean Water Act and Pennsylvania's Growing Greener Program to do restoration projects in their watersheds. The CVMP works with these groups to prepare a study design for a monitoring project that will study the impact of various Best Management Practices (BMPs) in local watersheds. The groups include the USC - Citizens for Land Stewardship, the Powells and Armstrong Creeks Watershed Association and the York County Watershed Alliance.

The USC-Citizens for Land Stewardship volunteer monitoring group is monitoring a natural stream channel design project since July 2001. Cross veins were placed in the stream and permanent cross sections were put above and below the project. The group will monitor the change in streambed yearly along with water chemistry monthly and macroinvertebrates and habitat twice a year. This holistic monitoring program will enable the volunteers to gauge stream improvements resulting from the project.

In addition to the above, the CVMP conducted an extensive review of programs within DEP to solicit additional potential uses for citizen-collected data. The list of potential uses include:

- Riparian buffer monitoring – Volunteers would monitor the effects on stream quality when buffers are restored.
- Wetland monitoring – Volunteers would check wetland losses and function changes (forested to emergent), monitor replacement sites, monitor advanced compensation wetlands, assess watershed to locate areas for wetland restoration projects and inclusion in the wetland registry.
- Habitat monitoring – Volunteers would monitor habitat loss including streams, wetlands and lakes over time.
- Survey stream obstructions – Volunteers would locate obstructions in the watershed including debris blockages, constricted culverts, etc.
- Watershed field views for abandoned mine land projects – Volunteers would do field views of watershed impacted by abandoned mining, locate seeps, and field test seeps for quality.
- Lake monitoring – Volunteers would do secchi depth monitoring and vegetation monitoring including invasive plants.
- Habitat surveys for TMDL remediation – Volunteers would perform follow-up biological and physical habitat.
- Stormwater management plan sampling – Volunteers would acquire physical data for stormwater planning in a watershed.
- Monitoring stormwater facilities – Volunteers would monitor the workings of stormwater facilities such as ponds, swales and ditches, and monitor their impacts on local watersheds.
- Zebra mussel monitoring – Volunteers would check streams for zebra mussels and their impacts, check special substrate samplers for zebra mussel infiltration.
- Streamwalks – Volunteers would do streamwalks to observe local conditions and to observe problems such as malfunctioning on-lot systems. This will also give agencies an idea of land use and impacts along the stream.
- Observe flood protection projects – Volunteers would check flood protection projects to make sure the structures are operational, and also check function during and after flood events.
- Winter stonefly monitoring – Volunteers monitor adult stoneflies in the winter, will give an idea of stream quality and will assist in setting up additional monitoring in summer/fall.
- Watershed field views for non-point source remediation projects – Volunteer would do watershed surveys to check on the success of non-point source restoration/remediation projects, observe stream conditions near the projects, land use and best management practices.

- In addition to these potential projects, DEP will be making a special effort to work with groups that get 319 funding. Volunteer will monitor the impacts of watershed restoration projects completed with the 319 funding.

### **Summary**

Community based monitoring is alive and well in Pennsylvania. The formation of the volunteer network, the continued training and mentoring from the CVMP and the development of new programs will enable volunteer monitoring to continue to grow. New projects including riparian buffer monitoring, lake monitoring and natural stream channel design monitoring will allow volunteers to continue to play a key role in protecting their water resources. Pennsylvania can move forward in developing and implementing watershed restoration plans including TMDLs by tapping into these rich resources and partnering with volunteer monitors.